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STABILIZATION PONDS FOR TREATMENT OF INDUSTRIAL WASTES. INVENTORY AND REFERENCE MATERIAL

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Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1961

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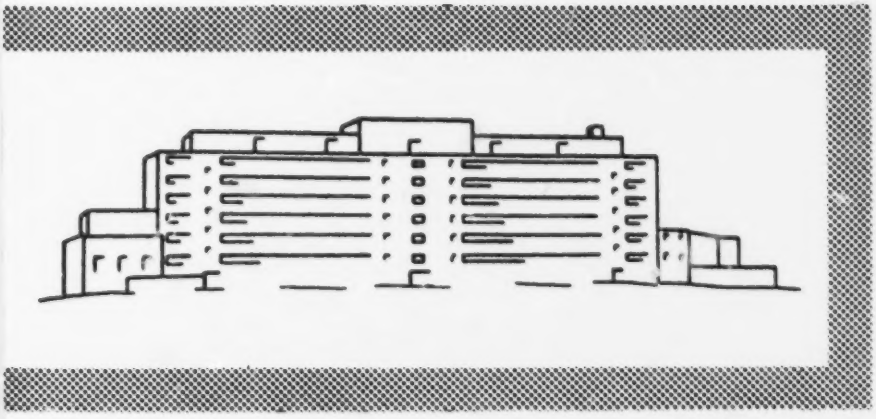

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W61-29

STABILIZATION PONDS

FOR

TREATMENT OF INDUSTRIAL WASTES

Inventory and Reference Material

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Technical Services Branch
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Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1961

CENTER PUBLICATIONS

The Robert A. Taft Sanitary Engineering Center is a national laboratory of the Public Health Service for research, training, and technical consultation in problems of water and waste treatment, milk and food safety, air pollution control, and radiological health. Its technical reports and papers are available without charge to professional users in government, education, and industry. Lists of publications in selected fields may be obtained on request to the Director, Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati 26, Ohio.

STABILIZATION PONDS FOR TREATMENT OF INDUSTRIAL WASTES

The use of ponds for disposal of industrial waste is not new. Such use of ponds or lagoons can be traced back for several decades and it is likely they existed prior to the time that their use was recorded. Lagooning of vegetable canning waste was reported as early as 1910 in New Jersey and 1913 in Illinois.* In the early uses ponds were used as seepage, settling or holding basins rather than as stabilization ponds. This storage often resulted in BOD reductions greater than those attributable to removal of suspended matter. More recently increased impetus has been given to treating various types of industrial waste in stabilization ponds where biochemical processes comparable to those prevailing in raw sewage stabilization ponds can be used to stabilize oxygen demanding materials. The Public Health Service has been following this trend for several years and steps have been taken to gather information where such facilities have been used as the principal method of industrial waste treatment.

In 1955 a joint Federal-State field study was initiated in the Dakotas to study waste stabilization ponds.† This work was stimulated by resolutions adopted by the 1954 Conference of State and Territorial Health Officers,and by requests from the Water Pollution Control Agencies of the Missouri Basin States that the Public Health Service investigate this means of waste treatment. More recently, the Agenda and Information Report (1960) of the National Technical Task Committee on Industrial Wastes recommended that the Public Health Service study stabilization ponds and lagoons for treating industial waste. This recommendation included the following:

> "Gather and evaluate data on the design and operation of sewage and industrial waste lagoons that are operating in the United States. The information should include definition of design, hydraulic capacity, basic climatological data, and operating data. Reports should show whether the installation operates as a single unit or in combination with other treatments. Additionally, study the following phases of aerobic lagoon design, presedimentation, recirculation and supplemental aeration".

Preliminary efforts have been made to gather information on 40 or 50 stabilization pond installations serving at least 10 different types of industries. A summary of this material has been published by Towne and Pahren.‡ These installations, most of which provide extremely satisfactory treatment, are being employed by the pulp and paper, meat packing, dairy, chicken processing, canning, laundry, organic chemical, and other industries. Much more data are needed, however, for comprehensive evaluation of loading factors and design criteria.

Pertinent data in Public Health Service Publication No. 622 (1958), 1957 Inventory of Municipal and Industrial Waste Facilities, were summarized and evaluated as the initial undertaking in preparation of this inventory and reference list. Also, information was obtained from published reports on any industrial waste lagoons that were not included in the 1957 Inventory. The results show that 1, 937 industrial waste lagoons were reported in use (Table I).

Specific uses were as follows:

Settling Lagoon	230
Sludge Lagoon	226
Oxidation Lagoon	148
Evaporation Lagoon	139
Combined-Function Lagoon	84
Lagoon (type not specified)	1,014
Regulated Discharge	96
Total	1,937

These lagoons were reported from virtually all States, the largest numbers being reported as follow:

Arkansas	70
California	199
Indiana	173
Kentucky	86
Maryland	73
Michigan	130
Minnesota	87
Ohio	153
Pennsylvania	260
Washington	75
West Virginia	64
Wisconsin	74

*Annual Report of State Board of Health of New Jersey, 1910, Illinois Water Survey Series No. 11, "The Investigations on the Disposal of Cannery Factory Wastes at Washington, Illinois," (1913).

†"Raw Sewage Stabilization Ponds in the Dakotas," Towne, W.W. et al. Sewage & Industrial Wastes, 29, 377-396 (April 1957).

‡"Use of Stabilization Ponds in Treating Sewage and Industrial Wastes," Towne, W.W. and Pahren, H. 8th Southern Municipal & Industrial Waste Conference, Chapel Hill, North Carolina (April 2-3, 1959).

Table I. NUMBER OF LAGOONS BY TYPES* IN VARIOUS STATES

State	Lp	Ls	Lo	Le	Lc	L	RD	Total
Alabama	0	0	1	2	0	2	2	7
Alaska	0	0	0	0	0	0	0	0
Arizona	0	1	2	3	0	16	0	22
Arkansas	0	0	2	64	1	3	0	70
California	10	67	30	11	12	60	9	199
Colorado	5	1	2	1	0	20	0	29
Connecticut	0	1	0	0	3	0	0	4
Delaware	0	2	0	0	1	2	0	5
D. C.	0	0	0	0	0	0	0	0
Florida	20	1	3	2	4	9	2	41
Georgia	0	0	1	0	2	0	0	3
Hawaii	0	3	1	0	0	0	0	4
Idaho	16	2	0	0	4	5	0	27
Illinois	2	1	3	0	1	33	2	42
Indiana	1	1	0	0	2	168	1	173
Iowa	0	1	3	0	0	7	1	12
Kansas	0	0	7	2	1	12	0	22
Kentucky	0	72	1	1	0	8	4	86
Louisiana	0	0	1	0	3	0	0	4
Maine	0	0	1	0	0	0	0	1
Maryland	18	2	1	16	1	34	1	73
Massachusetts	0	1	2	0	0	8	3	14
Michigan	24	24	5	9	4	43	21	130
Minnesota	65	0	2	3	4	12	1	87
Mississippi	0	0	1	0	0	4	0	5
Missouri	0	1	9	1	1	1	0	13
Montana	8	0	3	2	0	3	1	17
Nebraska	0	0	4	0	1	1	0	6
Nevada	0	0	0	1	0	0	0	1
New Hampshire	0	1	2	1	0	0	0	4
New Jersey	1	2	0	0	2	2	0	7
New Mexico	0	0	0	0	0	0	0	0
New York	2	0	4	0	4	40	3	53
North Carolina	2	0	8	1	0	1	0	12
North Dakota	0	0	6	1	0	2	0	9
Ohio	1	6	1	0	3	114	28	153
Oklahoma	0	1	0	2	1	2	0	6
Oregon	5	2	0	0	0	20	1	28
Pennsylvania	0	27	0	2	11	216	4	260
Rhode Island	0	0	0	1	1	3	1	6
South Carolina	0	0	0	0	0	12	1	13
South Dakota	1	0	5	0	1	0	0	7
Tennessee	0	0	0	0	3	0	0	3
Texas	1	0	1	2	4	1	0	9
Utah	0	0	0	1	0	11	0	12
Vermont	0	0	0	0	0	3	0	3
Virginia	0	5	7	0	2	8	1	23
Washington	41	1	11	2	4	10	6	75
West Virginia	4	0	0	0	1	58	1	64
Wisconsin	3	0	18	0	2	48	3	74
Wyoming	0	0	0	8	0	11	0	19
Total	230	226	148	139	84	1,014	96	1,937

*Types
Lp - Settling Lagoon
Ls - Sludge Lagoon
Lo - Oxidation Lagoon
Le - Evaporation Lagoon
Lc - Combined-Function Lagoon
L - Lagoon (type not specified)
R D - Regulated Discharge - lagoon may be present

The data were further broken down by industrial groups in Table II. Use by industrial grouping is as follows:

Metal Mining	163
Anthracite, Bituminous Coal and Lignite Mining	167
Crude Petroleum and Natural Gas Extraction	87
Mining and Quarrying of Nonmetallic Minerals except Fuels	127
Food and Kindred Products	581
Textile Mill Products	59
Lumber and Wood Products	93
Paper and Allied Products	88
Chemical and Allied Products	170
Products of Petroleum and Coal	71
Rubber and Rubber Products	5
Leather and Leather Products	33
Primary Metal Industries	55
Fabricated Metal Products	140
Miscellaneous Manfacturing	98

Of more interest might be a breakdown of reported oxidation ponds by industrial grouping:

Anthracite, Bituminous Coal, and Lignite Mining	3
Crude Petroleum and Natural Gas Extraction	4
Food and Kindred Products	104
Textile Mill Products	11
Paper and Allied Products	7
Products of Petroleum and Coal	9
Leather and Leather Products	1
Primary Metal Industries	1
Fabricated Metal Products	2
Miscellaneous Manfacturing	6
Total	148

Admittedly, these data are incomplete, yet they indicate the broad use of lagoons by industry. The development of a current inventory directed primarily to the use of stabilization ponds is underway and will provide an indication of the growth of acceptance of this type of treatment facility.

The second objective of the initial phase of this study was the development of a bibliography of references relating to experiences in the use of industrial waste lagoons. These selected references which follow have been compiled by Industrial Plant Classification to form a ready source of pertinent material.

Table II. NUMBER OF LAGOONS, BY TYPE[1]

STATE	INDUSTRY GROUP NUMBER*														
	(10)	(11)	(13)	(14)	(20)	(22)	(24)	(26)	(28)	(29)	(30)	(31)	(33)	(34)	(39)
Alabama	1 Le 2 RD	-	-	-	-	-	-	1 Lo 1 L	1 Le	-	-	-	-	-	-
Alaska	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arizona	8 L	-	-	-	-	1 Ls 2 Lo 1 Le 3 L	1 L	-	-	-	-	-	1 Le 3 L	1 L	1 Le
Arkansas	-	-	64 Le	-	1 L	-	-	2 Lo 1 Lc	-	-	-	-	1 L	-	1 L
California	4 Lp 6 Ls 1 Lc 7 L	1 Lo	2 Ls 3 Le 1 Lc 1 L 3 RD	1 Lp 2 Ls 2 L	1 Lp 6 Ls 25 Lo 1 Le 8 Lc 14 L	-	3 Lp 49 Ls 32 L 2 RD	1 Le	1 Ls 1 Le 2 Lc 1 L 1 RD	1 Lo 2 L	-	-	1 Lo	1 Lo 2 Le 1 RD	1 Lp 1 Ls 1 Lo 3 Le 1 L 2 RD
Colorado	5 Lp 8 L	4 L	1 L	-	1 Ls 2 Lo 4 L	-	-	-	-	2 L	-	-	-	1 Le	1 L
Connecticut	-	-	-	-	-	-	-	-	-	-	-	-	-	1 Ls	3 Lc
Delaware	-	-	-	-	1 Ls 1 L	-	-	-	1 L 1 Lc	-	-	-	-	-	1 Ls
D. C.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida	1 Lp 1 L	-	-	13 Lp	3 Lo 5 L	1 RD	1 Lc	1 Lp 1 Lc 1 L	5 Lp 1 Ls 2 Le 1 L 1 RD 1 Lc	-	-	1 L	-	-	1 Lc
Georgia	-	-	-	-	1 Lc	-	-	1 Lo 1 Lc	-	-	-	-	-	-	-
Hawaii	-	-	-	-	3 Ls 1 Lo	-	-	-	-	-	-	-	-	-	-

NUMBER OF LAGOONS, BY TYPE[1] (Continued)

STATE	INDUSTRY GROUP NUMBER*														
	(10)	(11)	(13)	(14)	(20)	(22)	(24)	(26)	(28)	(29)	(30)	(31)	(33)	(34)	(39)
Idaho	1 Lc 11 Lp 1 Ls	-	-	-	2 Lp 1 Ls 2 Lc 5 L	-	-	1 Lc	3 Lp	-	-	-	-	-	-
Illinois	2 Lp	4 L 2 RD	-	-	1 Lo 19 L 1 Lc	-	-	2 L	4 L	2 Lo 3 L	-	1 L 1 Ls	-	-	-
Indiana	-	1 L	--	-	139 L 1 RD 1 Lc	-	1 L	4 L	1 Ls 7 L	3 L	-	1 Lp 1 L	1 L 1 Lc	5 L	6 L
Iowa	-	-	-	-	3 Lo 6 L	-	-	-	-	-	-	-	1 Ls	1 RD 1 L	-
Kansas	-	-	4 Lo 3 L	-	1 Lo 1 L	-	-	-	1 Le 1 L	2 Lo 1 Lc 7 L	-	-	1 Le	-	-
Kentucky	-	62 Ls 1 Lo 5 L	-	-	3 Ls	1 Ls	-	-	3 Ls 1 Le 3 RD	1 Ls 2 L	1 L	1 Ls	1 RD	-	1 Ls
Louisiana	-	-	-	-	-	-	-	1 Lo 1 Lc	2 Lc	-	-	-	-	-	-
Maine	-	-	-	-	-	-	-	1 Lo	-	-	-	-	-	-	-
Maryland	-	-	-	15 Lp 3 Le 3 L	1 Lp 11 Le 25 L 1 Lo	2 L 1 RD	-	1 L 1 Lc	1 Lp 1 Ls 2 Le 2 L	-	-	1 L	1 Ls	-	1 Lp
Massachusetts	-	-	-	1 L	-	1 Ls 1 Lo 4 L	-	-	1 L 2 RD	-	-	1 L	-	1 RD	1 Lo 1 L
Michigan	5 Lp 9 L	-	-	2 Lp	2 Lp 2 Ls 4 Lo 2 Le 2 Lc 5 L 2 RD	-	-	1 Lp 15 Ls 3 L 2 RD	4 Lp 2 Ls 1 Le 7 L 6 RD	2 Lp 1 L 1 RD	1 RD	1 Ls 1 L	2 Ls 1 L 2 RD	8 Lp 2 Ls 1 Lo 6 Le 15 L 4 RD 2 Lc	1 L 3 RD

NUMBER OF LAGOONS, BY TYPE[1] (Continued)

STATE	INDUSTRY GROUP NUMBER*														
	(10)	(11)	(13)	(14)	(20)	(22)	(24)	(26)	(28)	(29)	(30)	(31)	(33)	(34)	(39)
Minnesota	65 Lp	-	-	1 Le	4 Lc 1 Le 10 L 1 Lo	-	-	1 L	1 RD	1 Lo 1 Le 1 L	-	-	-	-	-
Mississippi	-	-	-	-	1 Lo	-	1 L	-	3 L	-	-	-	-	-	-
Missouri	-	-	-	-	7 Lo	-	-	-	1 L	1 Ls	-	-	-	1 Le 1 Lc	1 Lo
Montana	7 Lp	-	-	-	3 Lo	-	-	-	-	2 Le 2 L 1 RD	-	-	-	-	1 Lp 1 L
Nebraska	-	-	-	-	4 Lo 1 L 1 Lc	-	-	-	-	-	-	-	-	-	-
Navada	-	-	-	-	-	-	-	-	1 Le	-	-	-	-	-	-
New Hampshire	-	-	-	-	-	1 Lo	-	-	-	-	-	1 Lo	-	1 Le	1 Ls
New Jersey	-	-	-	-	1 L	-	-	1 Lp	1 Ls 1 L 2 Lc	-	-	-	-	1 Ls	-
New Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New York	1 L	-	-	2 L	18 L 1 RD 4 Lo	-	-	1 Lc 2 RD	1 Lc 2 L	-	-	2 L	-	2 Lc 3 L	2 Lp 12 L
N. Carolina	-	-	-	-	-	6 Lo 1 Le 1 L	-	1 Lo	1 Lp	-	-	-	-	-	1 Lp 1 Lo
N. Dakota	-	1 Lo	-	-	2 Lo 1 Le 2 L	-	-	-	-	3 Lo	-	-	-	-	-
Ohio	-	19 L	-	15 L	1 Ls 22 L 3 RD 1 Lo 1 Lp 1 Lc	-	-	3 L	16 L 11 RD 1 Lc	2 L 1 Lc	2 L 1 RD	-	1 Ls 8 L 1 RD	4 Ls 17 L 11 RD	10 L 1 RD

NUMBER OF LAGOONS, BY TYPE[1] (Continued)

STATE	INDUSTRY GROUP NUMBER*														
	(10)	(11)	(13)	(14)	(20)	(22)	(24)	(26)	(28)	(29)	(30)	(31)	(33)	(34)	(39)
Oklahoma	-	-	1 Le	-	-	-	-	1 Ls	1 L	1 Le 1 Lc	-	-	-	1 L	-
Oregon	-	-	-	-	3 Lp 11 L	2 Lp 1 Ls 1 L	-	5 L	1 L	-	-	1 L	1 Ls 1 L 1 RD	-	-
Pennsylvania	4 L	3 L 1 Ls	1 L	1 Lc 44 L	5 Ls 2 Le 46 L 1 RD 1 Lc	2 Ls 10 L 1 Lc	-	3 Ls 1 Lc 9 L	2 Ls 21 L 1 Lc	2 Ls 10 L 1 RD	-	2 Ls 2 Lc 8 L	3 Ls 6 L 1 Lc	2 Ls 1 Lc 32 L 1 RD	5 Ls 2 Lc 23 L
Rhode Island	-	-	-	-	-	1 Le 1 Lc 3 L	-	-	-	-	-	-	-	1 RD	-
S. Carolina	-	-	-	-	1 L	6 L	1 L	1 L 1 RD	3 L	-	-	-	-	-	-
S. Dakota	1 Lp	-	-	-	5 Lo 1 Lc	-	-	-	-	-	-	-	-	-	-
Tennessee	-	-	-	-	-	-	-	-	2 Lc	-	-	-	-	-	-
Texas	-	-	1 L	-	1 Lo	-	-	1 Lc	2 Lc 2 Le	1 Lc	-	-	1 Lp	-	-
Utah	1 L	-	-	-	1 Le 6 L	-	-	-	1 L	1 L	-	-	1 L	-	-
Vermont	1 L	-	-	2 L	-	-	-	-	-	-	-	-	-	-	-
Virginia	-	-	-	1 L	2 Ls 6 Lo 1 L	1 L 1 Ls	-	1 Ls	2 L 2 Lc 1 Ls 1 RD	-	-	2 L	-	-	1 Lo 1 L
Washington	6 Lp 1 Le 1 Lc 1 L	9 Lp	1 Lp 1 L	13 Lp 1 L	2 Lp 10 Lo 1 Le 2 Lc 2 L 1 RD	1 Lo	-	1 Lp 1 Lc 1 L 2 RD	4 Lp 1 L	-	-	-	3 Lp 1 Ls 2 L	3 RD	2 Lp 1 L

NUMBER OF LAGOONS, BY TYPE[1] (Continued)

STATE	INDUSTRY GROUP NUMBER*														
	(10)	(11)	(13)	(14)	(20)	(22)	(24)	(26)	(28)	(29)	(30)	(31)	(33)	(34)	(39)
West Virginia	-	53 L	-	1 L	-	1 L	-	-	1 L 1 RD	-	-	1 Lp 2 L 1 Lc	2 Lp	-	1 Lp
Wisconsin	-	-	-	1 Lp 3 L	18 Lo 34 L 2 RD 1 Lc	-	1 L	6 L 1 RD	-	1 L	-	-	2 Lp 1 L 1 Lc	2 L	-
Wyoming	1 L	1 Le	-	-	2 L	-	1 L	-	3 Le 1 L	4 Le 4 L	-	-	-	1 L	1 L
TOTAL	107 Lp 7 Ls 2 Le 3 Lc 42 L 2 RD	9 Lp 63 Ls 3 Lo 1 Le 89 L 2 RD	1 Lp 2 Ls 4 Lo 68 Le 1 Lc 8 L 3 RD	45 Lp 2 Ls 4 Le 1 Lc 75 L	12 Lp 25 Ls 104 Lo 20 Le 26 Lc 383 L 11 RD	2 Lp 7 Ls 11 Lo 3 Le 2 Lc 32 L 2 RD	3 Lp 49 Ls 1 Lc 38 L 2 RD	4 Lp 20 Ls 7 Lo 1 Le 10 Lc 38 L 8 RD	18 Lp 13 Ls 15 Le 17 Lc 80 L 27 RD	2 Lp 4 Ls 9 Lo 8 Le 4 Lc 41 L 3 RD	? 2 RD	2 Lp 5 Ls 1 Lo 4 Lc 21 L	8 Lp 11 Ls 1 Lo 2 Le 25 L 5 RD 3 Lc	8 Lp 9 Ls 2 Lo 11 Le 9 Lc 78 L 23 RD	9 Lp 9 Ls 6 Lo 4 Le 3 Lc 61 L 6 RD
	163	167	87	127	581	59	93	88	170	71	5	33	55	140	98

* Group Number

Major Group No.	Industry Type	Major Group No.	Industry Type
10	Metal mining	26	Paper and allied products
11	Anthracite, bituminous coal, and lignite mining	28	Chemical and allied products
13	Crude petroleum and natural gas extraction	29	Products of petroleum and coal
14	Mining and quarrying of non-metallic minerals, except fuels	30	Rubber and rubber products
20	Food and kindred products	31	Leather and leather products
22	Textile mill products	33	Primary metal industries
24	Lumber and wood products	34	Fabricated metal products
		39	Miscellaneous manufacturing

[1] TYPES

Lp - Settling Lagoon
Ls - Sludge Lagoon
Lo - Oxidation Lagoon
Le - Evaporation Lagoon
Lc - Combined Function Lagoon
L - Lagoon (type not specified)
RD - Regulated Discharge - lagoon may be present

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(a) Corresponds to Group 10 according to Industrial Plant Classification from "Municipal Industrial Waste Facilities", a cooperative State-Federal report published by the U. S. Public Health Service in 1958.

(b) Group 11

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(d) Group 14

(e) Group 20A

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